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(54) **OPTICAL RECEIVER WITH REDUCED CAVITY SIZE AND METHODS OF MAKING AND USING THE SAME**

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G02B 6/12 (2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC 385/14–15, 31–39, 53
See application file for complete search history.

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(57) **ABSTRACT**

Methods for manufacturing and using an optical or optoelectronic device are disclosed. The optical or optoelectronic device and related methods may be useful as an optical or optoelectronic transceiver or for the processing of optical signals. The optical or optoelectronic device generally comprises a light-transmitting medium configured to transmit a first light beam; a light-receiving unit configured to receive and process a focused, reflected light beam; a first mirror or beam splitter configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit; a lens configured to focus the reflected light beam; and a second mirror configured to reflect the focused, reflected light beam towards the light-receiving unit.

21 Claims, 3 Drawing Sheets

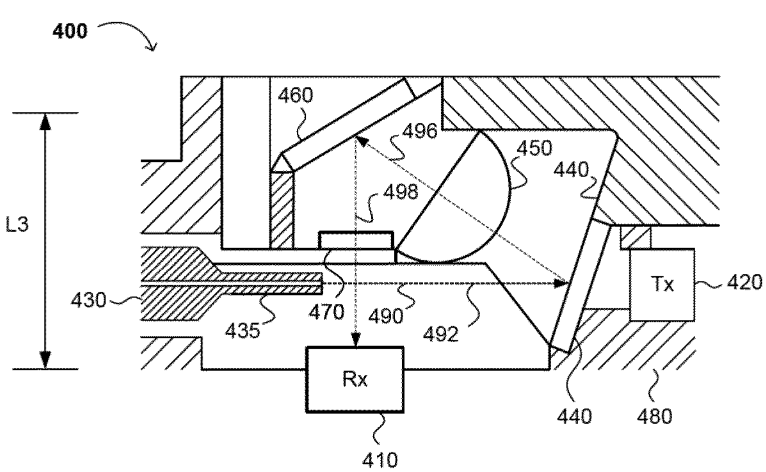

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FIG. 1

(Background)

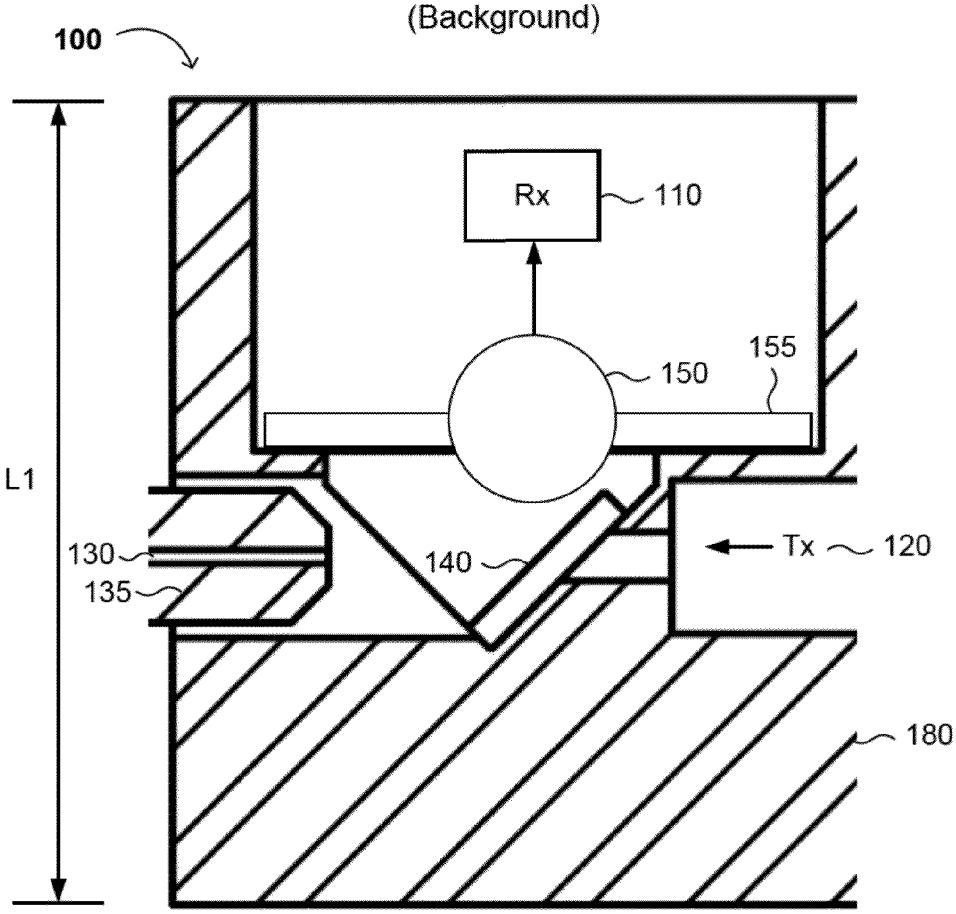


FIG. 2

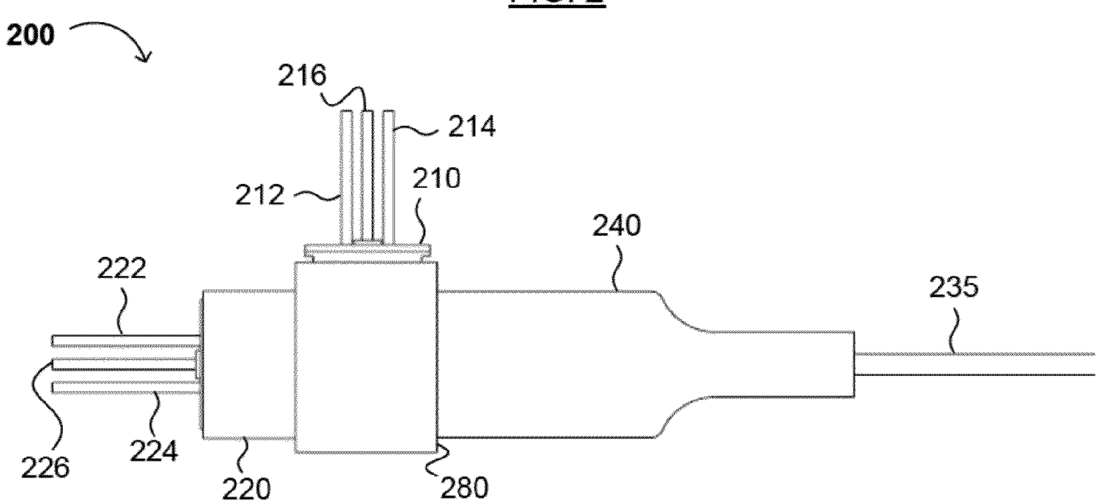


FIG. 3A

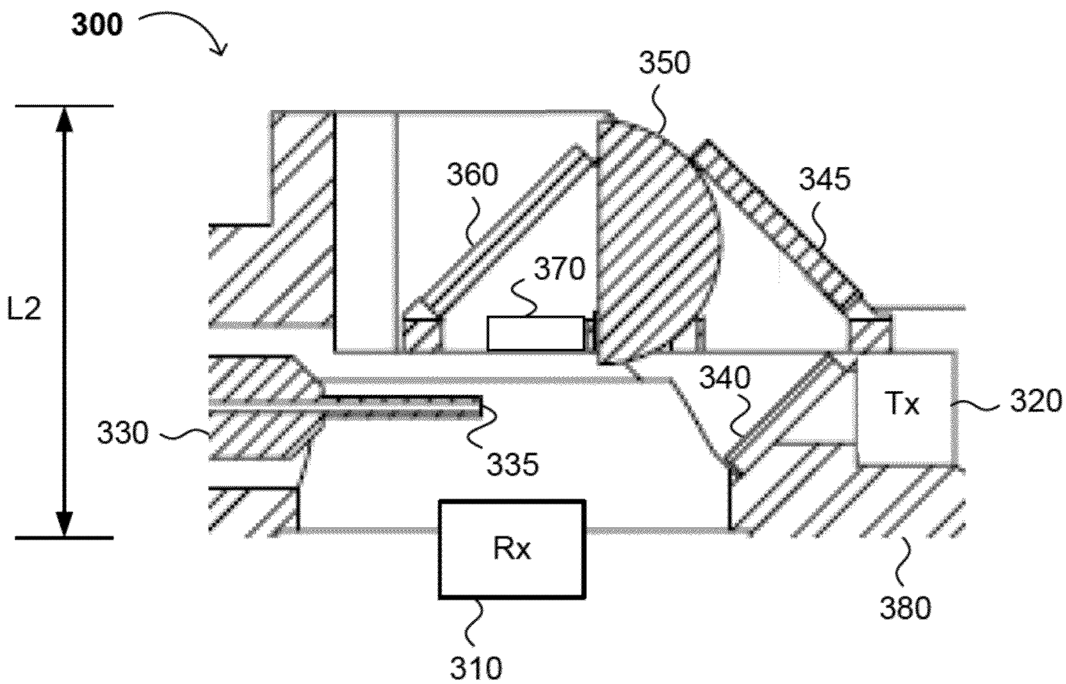

300
350
360
345
370
L2
340
Tx
320
330
335
Rx
380
310

FIG. 3B

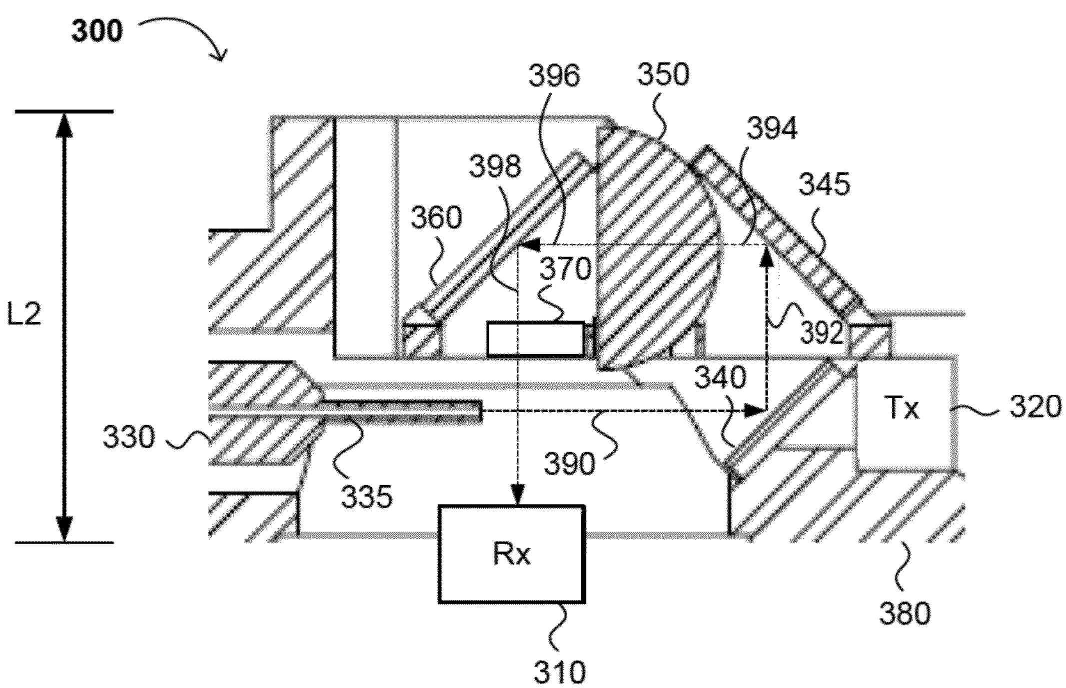

300
396
350
394
398
345
360
370
392
L2
340
Tx
320
330
390
335
Rx
380
310

FIG. 4A

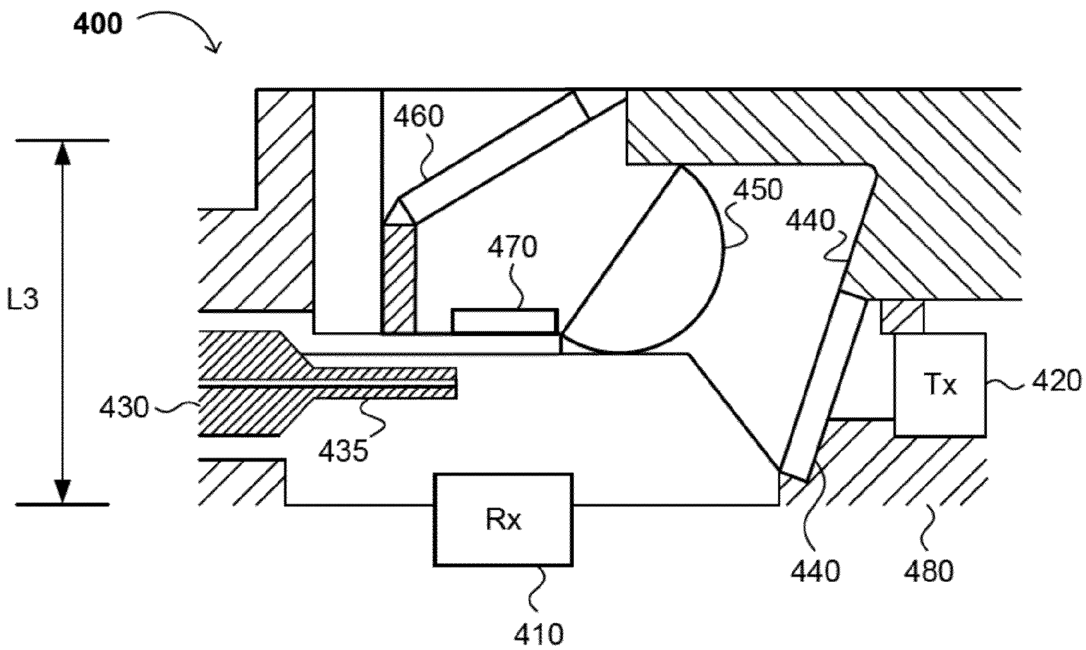
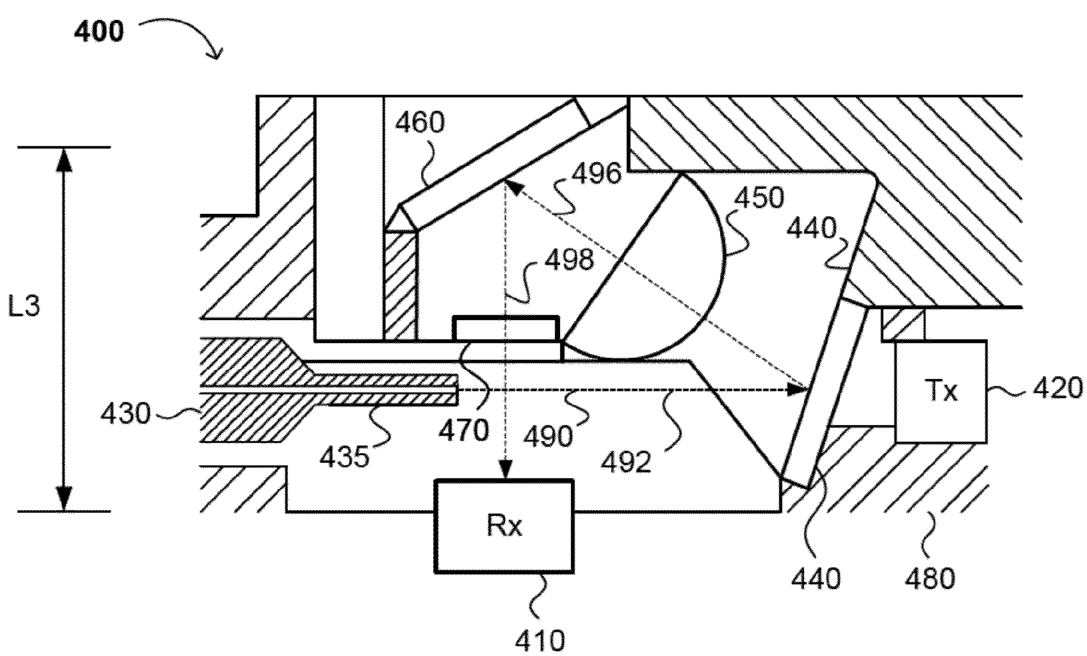

400
460
450
440
470
L3
Tx
420
430
435
Rx
440
480
410

FIG. 4B


400
460
496
450
440
498
L3
Tx
420
430
435
470
490
492
Rx
440
480
410

OPTICAL RECEIVER WITH REDUCED CAVITY SIZE AND METHODS OF MAKING AND USING THE SAME

FIELD OF THE INVENTION

The present invention generally relates to optical signal reception, and optionally, optical signal transmission. More specifically, embodiments of the present invention pertain to methods and apparatuses for receiving an optical signal using a light-processing cavity having a reduced size.

DISCUSSION OF THE BACKGROUND

FIG. **1** shows a portion of a conventional optical transceiver **100** having a housing **180**. The optical transceiver **100** comprises a light-carrying medium **130** (e.g., an optical fiber) which transmits a received optical signal towards a beam splitter **140**. At least a portion of the optical signal is reflected by beam splitter **140** towards a ball lens **150**. The reflected portion of the light passes through the lens **150** and is received by a light-receiving unit **110** (e.g., a photodiode). The lens **150** is positioned in a lens cap **155**. Thus, the housing **180** encompasses a light processing cavity in the optical transceiver **100**.

The transceiver **100** further comprises a transmitter **120** and an optical fiber **130** surrounded by a sheath **135**. The light-receiving unit **110** must be located in a portion of optical transceiver **100** that is orthogonal to and extends away from the transceiver **120** and sheath **135**.

FIG. **2** shows a conventional optical transceiver **200** with a conventional package, including a receiver portion **210**, a transmitter portion **220**, an optical fiber **235**, an optical fiber connection housing **240**, and a transceiver housing **280** which encompasses the conventional optical transceiver portion **100** of FIG. **1**, including the light processing cavity. Each of the receiver portion **210** and the transmitter portion **220** are fitted with four pins, a power supply pin **212** or **222**, a ground pin **214** or **224**, a data pin **216** or **226**, and a complementary data pin (not shown, but generally behind the data pin **216** or **226**). The width and thickness dimensions of transceiver housing **280** have a significant impact on the profile of optical transceiver **200**.

As shown in FIG. **1**, a dimension L1 of optical transceiver **100** and/or housing **180** may be relatively large, compared to the optical fiber connection housing **280** and transceiver **220** (FIG. **2**). Relatively large cross-sectional dimensions may be required for the housing **180** to house or encompass the components of optical transceiver **100**, based upon their arrangement in FIG. **1**.

However, the optical and optoelectronic network equipment industries seek ever-smaller transceiver packages and/or consumption of less space by functional components in the transceiver. Smaller packages enable more form-fitting network components, and smaller space consumption enables more functionality to be included within the same size package.

This "Background" section is provided for background information only. The statements in this "Background" are not an admission that the subject matter disclosed in this "Background" section constitutes prior art to the present disclosure, and no part of this "Background" section may be used as an admission that any part of this application, including this "Background" section, constitutes prior art to the present disclosure

SUMMARY OF THE INVENTION

The present invention is directed to an optical device that can reduce the space consumed by optical signal processing

components, thereby reducing the size of optical and optoelectronic devices such as optical and optoelectronic transceivers.

Embodiments of the present invention relate to an optical device, methods for making the optical device, and a method of processing an optical signal (for example, using the device). The optical device generally comprises a light-transmitting medium configured to transmit a first light beam; a light-receiving unit configured to receive and process a focused, reflected light beam; a first mirror or beam splitter configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit; a lens configured to focus the reflected light beam; and a second mirror configured to reflect the focused, reflected light beam towards the light-receiving unit.

In various embodiments, the optical device may further comprise (i) a third mirror configured to reflect the reflected light beam towards the second mirror and/or (ii) a light-transmitting unit configured to transmit a second light beam through the first mirror or beam splitter. In one architecture and/or arrangement, the second mirror may be positioned such that a first straight line between the second mirror and the light-receiving unit crosses a second straight line between the light-transmitting medium and the first mirror or beam splitter.

The method of manufacturing the optical device generally comprises affixing a light-transmitting medium in a housing of the optical device or into an opening in the housing of the optical device, the light-transmitting medium being configured to transmit a first light beam; affixing or adhering a light-receiving unit to the housing, the light-receiving unit being configured to receive and process a focused, reflected light beam; affixing or securing a first mirror or beam splitter within the housing, the first mirror or beam splitter being configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit; affixing or mounting a lens to or in the housing, the lens configured to focus the reflected light beam; and affixing a second mirror within the housing in a position configured to reflect the focused, reflected light beam towards the light-receiving unit.

In various embodiments, the method of manufacturing the optical device may further comprise (1) affixing a light-transmitting unit in the housing or into an opening in the housing, the light-transmitting unit being configured to transmit a second light beam through the first mirror or beam splitter, the second light beam (i) being received by the light-transmitting unit and (ii) having a wavelength different from that of the first light beam, and/or (2) filtering the reflected light beam. In one example, the light-receiving unit comprises a photodiode, and in one architecture and/or arrangement, the light-receiving unit may be positioned at a side of the light-transmitting medium opposite from the second mirror.

The method of processing an optical signal generally comprises receiving a first light beam from a light-transmitting medium; reflecting at least a first portion of the light beam away from a light-receiving unit; passing the reflected light beam through a lens to focus the reflected light beam; reflecting the reflected light beam towards the light-receiving unit; and receiving the focused, reflected light beam in the light-receiving unit. In various embodiments, the method of processing the optical signal may comprise reflecting the first portion of the light beam using a first mirror or beam splitter, and reflecting the reflected light beam towards the light-receiving unit using a second mirror. In one example, the sum of (i) an angle of incidence of the light beam upon the first mirror or beam splitter and (ii) an angle of incidence of the reflected light beam upon the second mirror is about 45°. In further embodiments, the light-transmitting medium may comprise an optical fiber having an unsheathed end proximate to the light-receiving unit.

Various embodiments and/or examples disclosed herein may be combined with other embodiments and/or examples, as long as such a combination is not explicitly disclosed herein as being unfavorable, undesirable or disadvantageous.

The present invention advantageously provides an optical receiver or transceiver with a reduced cavity size, enabling smaller sized packages and/or more functionality to be included within a similar sized package. By arranging components of an optical device according to the present invention (e.g., "folding" a light beam away from a light-receiving unit, in space that might otherwise be unused in the transceiver), the present invention enables an optical device to have a smaller, more compact design.

These and other advantages of the present invention will become readily apparent from the detailed description of various embodiments below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing part of a conventional optical transceiver.

FIG. **2** is a diagram showing an external housing for a conventional optical transceiver.

FIG. **3**A is a diagram showing an exemplary optical device according to the present invention.

FIG. **3**B is a diagram showing a use of the exemplary optical device of FIG. **3**A according to aspects of the present invention.

FIG. **4**A is a diagram showing an alternative optical device in accordance with additional aspects of the present invention.

FIG. **4**B is a diagram showing a use of the alternative optical device of FIG. **4**A.

DETAILED DESCRIPTION

Reference will now be made in detail to various embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the following embodiments, it will be understood that the descriptions are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents that may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be readily apparent to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

The present invention concerns an optical device, generally comprising a light-transmitting medium configured to transmit a first light beam; a light-receiving unit configured to receive and process a focused, reflected light beam; a first mirror or beam splitter configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit; a lens configured to focus the reflected light beam; and a second mirror configured to reflect the focused, reflected light beam towards the light-receiving unit.

A further aspect of the invention concerns a method of manufacturing an optical device, generally comprising the steps of affixing a light-transmitting medium in a housing of the optical device or into an opening in the housing of the optical device, the light-transmitting medium configured to transmit a first light beam; affixing or adhering a light-receiving unit to the housing, the light-receiving unit configured to receive and process a focused, reflected light beam; affixing or securing a first mirror or beam splitter within the housing, the first mirror or beam splitter configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit; affixing or mounting a lens to or in the housing, the lens configured to focus the reflected light beam; and affixing a second mirror within the housing in a position configured to reflect the focused, reflected light beam towards the light-receiving unit.

Even further aspects of the invention concern a method of processing an optical signal, generally comprising receiving a first light beam from a light-transmitting medium; reflecting at least a first portion of the light beam away from a light-receiving unit; passing the reflected light beam through a lens to focus the reflected light beam; reflecting the focused, reflected light beam towards the light-receiving unit; and receiving the focused, reflected light beam in the light-receiving unit.

The invention, in its various aspects, will be explained in greater detail below with regard to exemplary embodiments.

An Exemplary Optical Device

FIG. **3**A shows an exemplary optical device **300** according to the present invention. Optical device **300** may be an optical transceiver or other device capable of receiving and processing an optical signal. Optical device **300** may comprise or be contained within a housing **380**. The housing **380** may have an opening through which a light-carrying or light-transmitting medium **335** is placed. The light-transmitting medium **335** may comprise an optical fiber which may be surrounded (or sheathed) by a ceramic material **330**. A portion of the optical fiber may be uncovered (or unsheathed) at an end closest to a light-receiving unit **310**. The light-carrying or light-transmitting medium **335** may be configured to carry or transmit a light beam or optical signal. Typically, the light beam or optical signal is a diffuse light beam or optical signal (e.g., slightly cone-shaped and/or having a characteristic enlargement or spreading of the beam size, width or diameter as a function of distance), but the invention is also applicable to other light beams or optical signals, such as polarized and/or collimated light beams or optical signals. In many embodiments, more than one signal may be simultaneously carried or transmitted by the light-transmitting medium **335**, each signal having a different wavelength. For example, a first signal at a first wavelength or wavelength band may be received by optical device **300**, and a second signal at a second wavelength or wavelength band significantly different from the first wavelength or wavelength band may be transmitted by optical device **300**.

The optical device **300** comprises a first beam splitter **340** configured to reflect at least a portion of the light beam emitted from light-transmitting medium **335**. First beam splitter **340** and light-transmitting medium **335** may be aligned such that the light beam transmitted by light-transmitting medium **335** is incident upon first beam splitter **340**. In one embodiment, the angle of incidence of the transmitted light beam upon first beam splitter **340** may be about 45° (e.g., exactly 45°). When the optical device includes a receiver that does not have a transmitter (e.g., **320**) aligned with the light-transmitting medium (e.g., **335**), the beam splitter **340** may be or comprise a mirror.

First beam splitter **340** reflects at least a portion of the light beam away from the light-receiving unit **310** (see, e.g., FIG.

3B). The reflected portion of the light beam may comprise light of a first wavelength. In one embodiment, all light transmitted from the light-transmitting medium **335** to the first beam splitter **340** is reflected. First beam splitter **340** may also allow a second beam (or a second portion of the incident light beam) to pass through. The light which passes through first beam splitter **340** generally comprises light of a second wavelength, where the second wavelength is different from the first wavelength. The first and second wavelengths may differ by a minimum of about 100-200 nm, generally up to about 500-1000 nm. Alternatively, the first and second wavelengths may differ by at least about 5, 10, 15 or 20%, up to as much as 25, 50 or 100%. In various embodiments, the first beam splitter **340** may comprise a dichroic mirror, a wavelength selective filter (made of or coated with a reflective material), a polarization component, an amplitude modulation mask, a phase modulation mask, a hologram, and/or a grating.

The optical device **300** may further comprise a light-transmitting unit **320** which may be configured to transmit light that passes through first beam splitter **340**. Light-transmitting unit **320** and light-transmitting medium **335** may be aligned such that the light beam or optical signal transmitted by light-transmitting unit **320** enters or is incident upon the end of light-transmitting medium **335**. Light-transmitting unit **320** may be configured to transmit a second light beam or optical signal through first beam splitter **340**, the second light beam being received by the light-transmitting medium **335**. In other words, optical device **300** may be configured as a bi-directional (BIDI) optical device. Alternatively, a second portion of the light beam emitted the light-carrying medium **335** towards the first beam splitter **340** may pass through the first beam splitter **340** and be received by a second light-receiving unit (not shown). However, in the case where the light beam emitted the light-carrying medium **335** is diffuse, the portion of the light beam passing through the first beam splitter **340** should be focused by a second lens before being reflected by a mirror or beam splitter in a second light-processing unit (not shown) substantially similar to that shown in FIG. **3**A.

The optical device **300** may also comprise mirrors **345** and **360** (which may be referred to as, for example, intermediate mirror **345** and final mirror **360**) configured to reflect light from first beam splitter **340** towards the light-receiving unit **310**. In one embodiment, the angle of incidence of the reflected light beam upon intermediate mirror **345** may be about 45° (e.g., exactly 45°). Intermediate mirror **345** may be positioned at an angle of about 90° (e.g., exactly 90°) with respect to first beam splitter **340**.

Final mirror **360** may be configured to reflect the light beam towards the light-receiving unit **310**. The light beam which is incident upon final mirror **360** may be the focused light beam which has passed through lens **350**. Final mirror **360** may be positioned at an angle of about 90° (e.g., exactly 90°) with respect to intermediate mirror **345**. Final mirror **360** may be positioned such that a light beam reflected from final mirror **360** is in a direct path toward light-receiving unit **310**.

The optical device **300** may also comprise a lens **350** configured to focus the reflected light beam (see, e.g., FIG. **3**B). The lens **350** may focus the received and/or incident light that passes through the lens **350**, and is thus particularly advantageous when the received light beam **390** is a diffuse light beam. Lens **350** may be a half ball lens, which may comprise a curved surface facing intermediate mirror **345** and a flat surface facing final mirror **360**. Alternatively, the lens may comprise a concave lens, a convex lens, and/or or a combination of concave or convex lenses. Lens **350** can be placed anywhere in the light path (e.g., between first beam splitter **340** and intermediate mirror **345**, between final mirror **360** and light-receiving unit **310**, etc.), but doing so may affect the extent of the cavity size reduction and, when the light beam is diffuse, the diameter or width of the light beam at certain points in the device **300** (e.g., as it enters the receiver **310**).

The optical device **300** may also comprise a filter **370** between final mirror **360** and light-receiving unit **310**, configured to filter (e.g., reduce the wavelength band of) the light beam traveling between final mirror **360** and light-receiving unit **310**. Filter **370** may comprise material(s) known in the art that are capable of blocking certain predetermined wavelengths of light from passing through. The filter **370** can be placed elsewhere along the light path (see, e.g., FIG. **3**B). For example, filter **370** may be placed between first beam splitter **340** and intermediate mirror **345**, between lens **350** and final mirror **360**, or attached to, affixed to or integrated within the lens **350**, etc.

The optical device **300** may also comprise a light-receiving unit **310**. The light-receiving unit **310** may comprise (1) a photodiode (e.g., a PIN photodiode) or other light-detecting component(s) and (2) an amplifier (e.g., a transimpedence amplifier and/or a limiting amplifier). The light-receiving unit **310** may be positioned at a side of the light-transmitting medium **335** opposite from final mirror **360**. Light-receiving unit **310** may be configured to receive the light beam from final mirror **360**.

Thus, due to the arrangement of optical device **300** of FIG. **3**A, the dimension L**2** of optical transceiver **300** and/or housing **380** may be relatively small, as compared to the dimension L**1** of FIG. **1**. A relatively small cross-sectional dimension enables the housing **380** to have a smaller profile, fit in a smaller package, and/or house or encompass additional components (and thus additional functionality) within optical device **300**.

FIG. **3**B shows a path that a light beam may take within the light processing cavity of optical device **300** of FIG. **3**A. Referring to FIG. **3**B, a light beam (or optical signal) **390** may be emitted from light-transmitting medium **335**, after which the light beam **390** is incident upon first beam splitter **340**, where it is reflected in whole or in part towards intermediate mirror **345** as reflected light beam **392**. Intermediate mirror **345** reflects the light beam **392** through lens **350**, which focuses the reflected light beam **394**. When the light beam **392** is diffuse, light beam **394** will have a smaller size, width or diameter than light beam **392**. The focused light beam **396** is incident upon final mirror **360**, which reflects the focused light beam **396** towards light-receiving unit **310**. The focused, reflected light beam **398** is received in or on the light-receiving unit **310** after passing through filter **370**.

As shown in FIG. **3**B, the components of optical device **300** may be arranged such that a first straight line between the final mirror **360** and the light-receiving unit **310** crosses a second straight line between the light-transmitting medium **335** and the first beam splitter **340**. The first and second straight lines may be perpendicular to each other (e.g., may cross each other at right angles). A third straight line between final mirror **360** and intermediate mirror **345** may be parallel to the second straight line between the light-transmitting medium **335** and the first beam splitter **340**. A fourth straight line between intermediate mirror **345** and first beam splitter **340** may be parallel to the first straight line between the final mirror **360** and the light-receiving unit **310**.

The lens **350** may be in the path of the third straight line between final mirror **360** and intermediate mirror **345**. Alternatively, lens **350** may be in the path of the first straight line between final mirror **360** and receiver **310** (e.g., it may be mounted on receiver **310**), or in the path of the fourth straight line between first beam splitter **340** and intermediate mirror **345**. In the case where final mirror **360** comprises a dichroic mirror, wavelength selective filter, polarization component, amplitude and/or phase modulation mask, hologram and/or grating, intermediate mirror **345** may be on the second straight line, on a side of the final mirror **360** opposite from the light-receiving unit **310**. Light-transmitting unit **320** may be on the first straight line at a side of the first beam splitter **340** opposite from the light-transmitting medium **335**.

An Alternative Optical Device

FIG. **4**A shows an alternative optical device (e.g., an optical transceiver) **400** in accordance with additional aspects of the present invention. Optical device **400** may comprise or be contained within a housing **480**. Optical device **400** may comprise a light-transmitting medium **435** having a sheath **430**, a light-receiving unit **410**, a first beam splitter **440**, a light-transmitting unit **420**, a lens **450**, a second mirror **460**, and a filter **470** in an arrangement similar to optical device **300** (see FIG. **3**A). However, as shown in FIG. **4**A, optical device **400** includes only two mirrors (or a mirror and a beam splitter).

For example, first beam splitter **440** and light-transmitting medium **435** may be aligned such that the light beam transmitted by light-transmitting medium **435** is incident upon beam splitter **440** at an angle of about 13° (e.g., 13±0.5° [or any positive amount less than 0.5°], and in one embodiment, exactly 13°). Such an angle of incidence of the first beam splitter **440** may be advantageous in the case where the received light beam (e.g., light beam **490** in FIG. **4**B) is polarized and/or collimated, but the optical device **400** is also effective and advantageous when the received light beam is diffuse. Second mirror **460** and first beam splitter **440** may be aligned such that the light beam reflected by first beam splitter **440** is incident upon second mirror **460** at an angle of about 32° (e.g., 32±0.5° [or any positive amount less than 0.5°], and in the same embodiment, exactly 32°). Thus, a sum of (i) an angle of incidence of the light beam upon the first beam splitter **440** and (ii) an angle of incidence of the light beam upon the second mirror **450** may equal about 45° (e.g., 45±0.5° [or any positive amount less than 0.5°], and in the embodiment shown in FIG. **4**A, exactly 45°).

Similar to optical device **300** in FIG. **3**A, due to the arrangement of components within the optical device **400** of FIG. **4**A, a dimension L**3** of optical transceiver **400** and/or housing **480** may be relatively small, compared to the dimension L**1** of FIG. **1** and the dimension L**2** of FIG. **3**A. A relatively small cross-sectional dimension enables the housing **480** to have a smaller profile, fit in a smaller package, and/or house or encompass additional components within optical device **400**.

FIG. **4**B shows a path that a light beam may take in the optical device of FIG. **4**A (i.e., optical device **400**). Referring to FIG. **4**B, a light beam (or optical signal) **490** may emanate from light-transmitting medium **435**, after which the light beam **490** is incident upon first beam splitter **440**, where it is reflected in whole or in part towards lens **450** as reflected light beam **492**. After passing through lens **450**, the focused light beam **496** is incident upon second mirror **460**, which reflects the light beam **496** towards light-receiving unit **410**, wherein the reflected, focused light beam **498** is received in or at the light-receiving unit **410**.

As shown in FIG. **4**B, the components of optical device **400** may be arranged such that a first straight line between the second mirror **460** and the light-receiving unit **410** crosses a second straight line between the light-transmitting medium **435** and the first beam splitter **440**. The first and second straight lines may be perpendicular to each other (e.g., may cross each other at right angles). A third straight line between second mirror **460** and first beam splitter **440** may be neither parallel nor perpendicular to either the first straight line or the second straight line, but may be normal or perpendicular to the surface of the lens **450** (e.g., the planar surface of half-ball lens **450**). Thus, the lens **450** may be in the path of the third straight line between second mirror **460** and first beam splitter **440**. Second mirror **460** may be at an opposite side of the second straight line from the light receiving unit **410**. Light-transmitting unit **420** and first beam splitter **440** may be at an opposite side of the first straight line from the light-transmitting medium **435**.

CONCLUSION/SUMMARY

Thus, the present invention provides an optical device, methods for making the optical device, and a method of processing an optical signal (for example, processing the optical signal using the device).

The foregoing descriptions of specific embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

What is claimed is:

1. An optical device, comprising:
- a light-transmitting medium configured to transmit a first light beam;
- a light-receiving unit comprising a photodiode, configured to receive and process a focused, reflected light beam;
- a first mirror or beam splitter configured to reflect at least a first portion of the transmitted light beam away from the light-receiving unit;
- a lens configured to focus the reflected light beam;
- a second mirror configured to reflect the focused, reflected light beam towards the light-receiving unit; and
- a housing having an opening that receives the light-transmitting medium, wherein the housing contains the first mirror or beam splitter, the lens, and the second mirror.

2. The device of claim **1**, further comprising a third mirror within the housing configured to reflect the reflected light beam towards the second mirror.

3. The device of claim **2**, wherein the first mirror or beam splitter is oriented at about a 45 degree angle relative to the transmitted light beam, the third mirror is oriented at about a 90 degree angle relative to the first mirror or beam splitter, and the second mirror is oriented at about a 90 degree angle relative to the third mirror.

4. The device of claim **2**, wherein the lens is between the third mirror and the second mirror.

5. The device of claim **1**, wherein a sum of (i) an angle of incidence of the transmitted light beam upon the first mirror or beam splitter and (ii) an angle of incidence of the reflected light beam upon the second mirror is about 45°.

6. The device of claim **1**, further comprising a light-transmitting unit configured to transmit a second light beam through the first mirror or beam splitter, wherein:
- the first portion of the transmitted light beam has a first wavelength;

the second light beam (i) is received by the light-transmitting medium and (ii) has a wavelength different from that of the first wavelength; and

the light-transmitting unit is affixed or adhered to the housing, or the housing further contains the light-transmitting unit.

7. The device of claim **1**, wherein:

the light-transmitting medium comprises an optical fiber; and

a portion of the optical fiber at an end of the optical fiber proximate to said light-receiving unit is unsheathed.

8. The device of claim **1**, wherein the second mirror is positioned such that a first straight line between the second mirror and the light-receiving unit crosses a second straight line between the light-transmitting medium and the first mirror or beam splitter.

9. The device of claim **1**, wherein the reflected light beam passes through the lens.

10. The device of claim **1**, wherein the received light beam is a diffuse light beam.

11. The device of claim **1**, further comprising a filter along a light path of the reflected light beam or the focused, reflected light beam, configured to filter the reflected light beam or the focused, reflected light beam.

12. The device of claim **11**, wherein the filter is between the second mirror and the light-receiving unit, and is configured to reduce the wavelength band of the focused, reflected light beam.

13. The device of claim **1**, wherein the light-receiving unit is affixed or adhered to the housing, or the housing further contains the light-receiving unit.

14. A method of processing an optical signal, comprising:

receiving a first light beam from a light-transmitting medium in an opening in a housing of an optical device, wherein the opening receives the light-transmitting medium;

reflecting at least a first portion of the light beam away from a light-receiving unit using a first mirror or beam splitter, wherein the light-receiving unit comprises a photodiode, and the housing contains the first mirror or beam splitter;

passing the reflected light beam through a lens to focus the reflected light beam, wherein the housing further contains the lens;

reflecting the focused, reflected light beam towards the light-receiving unit using a second mirror, wherein the housing further contains the second mirror; and

receiving the focused, reflected light beam in the light-receiving unit.

15. The method of claim **14**, wherein:

at least the first portion of the light beam is reflected by a first mirror or beam splitter oriented at about a 45 degree angle relative to the light beam; and

the reflected light beam is reflected towards the light-receiving unit by a second mirror oriented at about a 45 degree angle relative to an incident light beam; and

the method further comprises reflecting the reflected portion of the light beam towards the second mirror using a third mirror oriented at a 90 degree angle relative to the first mirror or beam splitter.

16. The method of claim **15**, further comprising transmitting a second light beam through the first mirror or beam splitter, the second light beam being received by the light-transmitting medium.

17. The method of claim **14**, wherein:

at least the first portion of the light beam is reflected by a first mirror or beam splitter; and

the reflected light beam is reflected towards the light-receiving unit by a second mirror; and

a sum of (i) an angle of incidence of the light beam upon the first mirror or beam splitter and (ii) an angle of incidence of the reflected light beam upon the second mirror is about 45°.

18. The method of claim **17**, wherein the angle of incidence of the light beam upon the first mirror or beam splitter is about 13±0.5°, and an angle of incidence of the reflected light beam upon the second mirror is about 32±0.5°.

19. The method of claim **14**, wherein:

the light-transmitting medium comprises an optical fiber having an unsheathed end proximate to said light-receiving unit;

the second mirror is positioned such that a first straight line between the second mirror and the light-receiving unit crosses a second straight line between the light-transmitting medium and the first mirror or beam splitter; and

the light-receiving unit is at a side of the light-transmitting medium opposite from the second mirror.

20. The method of claim **14**, further comprising filtering the reflected light beam or the focused, reflected light beam, configured to filter the reflected light beam or the focused, reflected light beam.

21. The method of claim **14**, wherein the light-receiving unit is affixed or adhered to the housing, or the housing further contains the light-receiving unit.

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